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Supplementary appendix

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Web Extra Material for the Benefits of Enhanced Terminal Room (BETR) Disinfection Study

Supplement to the Methods

Nine hospitals participated in the study over a 28-month study period from April 2012 through July 2014, including two academic, tertiary care referral centers, one Veterans Affairs medical center, and six community hospitals participating in the Duke Infection Control Outreach Network (Supplemental Table 1).

Daily room cleaning (i.e., not terminal) was unchanged during the study and was performed using a quaternary ammonium-containing disinfectant for all rooms except for rooms of patients suspected or known to have *C. difficile*, in which a bleach-containing disinfectant was used.

Standardization of Terminal Room Disinfection Strategies

All hospitals used disinfectant products provided by the study and protocol-defined processes to clean targeted rooms. Each hospital received supplies of quaternary ammonium-containing disinfectant (EnCompass Quaternary Disinfectant Cleaner and the EnCompass System, Ecolab, St. Paul, Minnesota), buckets, dispensers, and microfiber cloths to ensure consistency in product application to surfaces. Environmental services (EVS) personnel were trained at the beginning of each study arm on the appropriate use of the chemical, dispensers, and the microfiber cloths; general best practices for cleaning; and the importance of cleaning high touch objects. Targeted rooms were terminally cleaned using microfiber cloths saturated with disinfectant from "clean" buckets and transferred to "dirty" buckets after use. Microfiber cloths were color coded to ensure separation of cleaning of the bathroom/toilet from the rest of the hospital room. Each hospital also received supplies of bleach-containing disinfectant (Clorox Germicidal Wipes, Clorox, Oakland, CA). EVS personnel were similarly instructed at the beginning of each study arm on the appropriate use of these 12" x 12" pre-saturated wipes (1:10 dilution). Wipes were discarded after use. EVS personnel cleaned non-targeted rooms using standard approaches used at each individual study hospital.

Strategies B and D involved the use of automated UV emitting devices (Tru-D SmartUVC™; Memphis, TN). Eight study hospitals were provided 1 to 4 of these devices for use during the study, based on hospital size; one study hospital purchased 4 devices prior to the initiation of the study.

Shadowing with the use of UV devices is important. Members of our study team performed an analysis comparing the effectiveness of UV-C radiation on our target pathogens using pre-specified amounts of each organism on formica plates (Rutala et al. ICHE 2010; 31:1025-29). Indeed, UV-C radiation was more effective when there was a direct line of sight to the contaminant (MRSA, p=0.06; VRE, p=0.003; *A. baumannii*, p=0.07; *C. difficile*, p<0.001), but meaningful reduction did occur when the contaminant was not directly exposed to the UV-C (mean reduction, 3.3–3.9 log10). Since data demonstrate that the microbial load of epidemiologically important pathogens such as *C. difficile* is generally <10 CFU/Rodac, we concluded a >2 log reduction of shadowed areas would be clinically effective.

One strategy to overcome shadowing is to use more than 1 stage. Boyce et al. compared the effectiveness of 1-stage vs. 2-stage deployment of UV-C devices, comparing reduction in CFU in 20 rooms in which the UV-C device was placed in the center of the room (1-stage) and five rooms in which the UV-C device was placed in the bathroom for one stage and in the room for an additional stage (2-stage; Boyce et al. ICHE 2011;32:737-42). The overall log-reduction was 2.2 for the 1-stage and 2.3 for the 2-stage approach. While the log reduction was higher for the shower floor and toilet in the 2-stage approach, it was lower for the chair and floor compared to the 1-stage approach. Importantly, the room turnover time increased by approximately 20 minutes when using the 2-stage approach.

We ultimately chose to use a 1-stage approach because of concerns about increased room turnover time with the 2-stage approach and potential subsequent difficulty completing the UV disinfection. Our standardized protocol were designed to reduce the impact of shadowing. First, the automated UV devices emit light at 254 nm wavelength and measure the reflected dose of light using eight sensors mounted on the device. Each device was programmed to deliver a reflected dose of 12,000 $\mu Ws/cm^2$ for vegetative bacteria (MRSA, VRE, or *Acinetobacter*) or 22,000 $\mu Ws/cm^2$ for *C. difficile*. A cleaning cycle was deemed to be complete only after all eight sensors detected a sufficient reflected dose, implying that even areas in shadow had received sufficient UV radiation. Second, local EVS personnel were trained and provided standardized protocols for use of the devices. More specifically, EVS personnel were instructed to open drawers and cabinets prior to use of the machine. Third, in light of the concern

regarding shadowing in the bathroom described above, EVS personnel were also instructed to place the UV device approximately in the center of the targeted room while ensuring that light from at least 3 bulbs was emitted into the room's bathroom. If this requirement could not be achieved with the machine close to the center of the room, the UV device was preferentially placed in front of the bathroom door to ensure UV radiation in the bathroom.

Protocol Implementation

The study team visited each participating hospital prior to the beginning of each study arm to explain strategies for protocol implementation. Local personnel typically included hospital administration, bed control, infection preventionists, nursing staff, and EVS directors and supervisors. Each hospital developed local protocols and systems for 1) identification of eligible rooms, 2) use of the appropriate disinfectant chemicals, and 3) deployment of the UV device. As an example, hospitals used a redundant system for identification of eligible targeted rooms that included use of door signs, rounding by infection preventionists, bed control notification, and environmental rounds to identify and communicate eligible rooms. As part of this process, each hospital identified an EVS champion for the execution of the study. All hospitals ultimately used the same strategy for deployment and use of the UV devices. EVS supervisor(s) were assigned this responsibility each shift. Study hospitals used different strategies for delivery of the appropriate disinfectant chemicals, including providing study disinfectants to all housekeepers, identifying housekeepers to clean study rooms, and/or direct assignment of a housekeeper and receipt of the appropriate disinfectant immediately prior to terminal clean for each individual targeted room.

The study team held regular "collaborative" calls with EVS champions, EVS supervisors, and infection preventionists at each study hospitals. These calls were used to provide study updates, feedback on protocol compliance, and were used to discuss problems that occurred at study hospitals and collectively devise strategies to overcome these problems. These collaborative calls occurred weekly during the wash-in periods and initial 1 to 2 months of each study arm and biweekly thereafter.

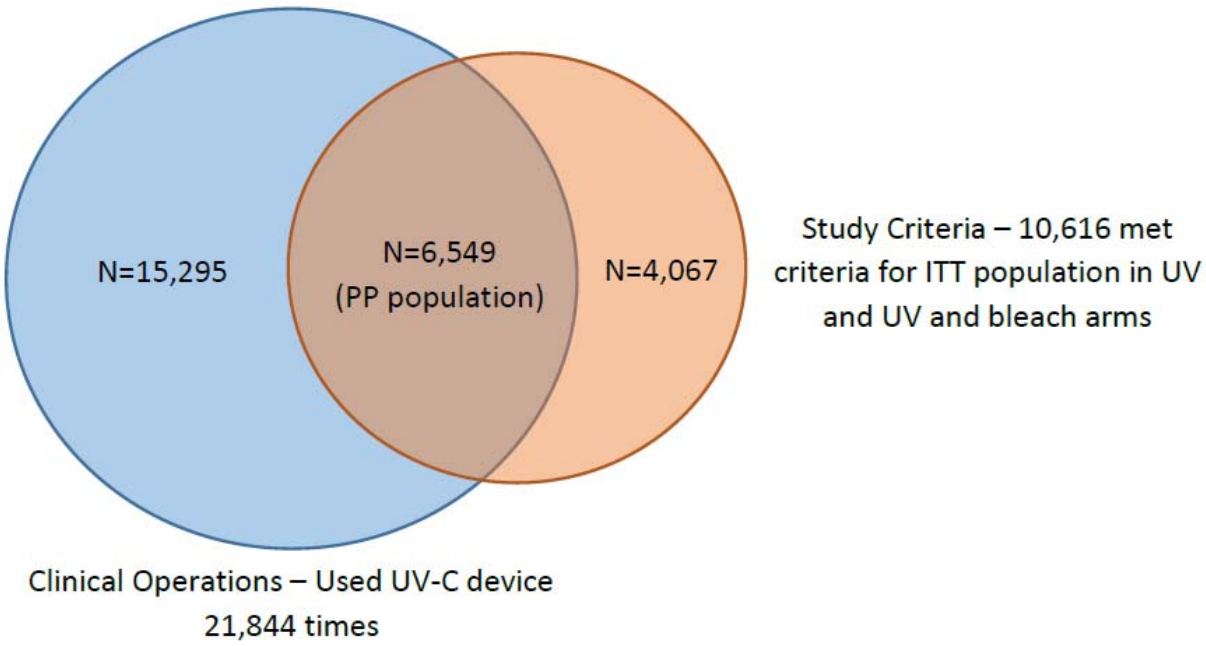
Protocol Fidelity

Each hospital monitored compliance with the study protocols as follows: EVS supervisors randomly sampled five or more study rooms each week using a pH pen to document use of the appropriate disinfectant. Supervisors marked the bedside table with a pH pen following terminal clean to determine if a quaternary ammonium- (pH=7) or bleach- (pH=10) containing disinfectant was used. Supervisors recorded the results of these tests on a standardized form to send to the study team. Each time a UV device was deployed, EVS supervisors completed a data collection card that recorded the room number, date, start and stop time, type of cycle, if the cycle was completed, and if not, the reason the cycle was aborted. Uses of the UV device were then compared to lists of patients on contact precautions in order to calculate compliance.

The study team provided feedback on pH pen compliance and UV device use compliance data to each hospital via weekly emails and during the collaborative calls. If compliance with either compliance measure was low or declining, the study team contacted the local study personnel to develop strategies to improve compliance. Compliance goals were set at ≥90% for each protocol component.

ITT vs. PP Populations

Differences in the number of patients included in the ITT analyses and PP analyses were expected. At its core, the reason for the discrepancy between the two populations was related to our pragmatic approach to implementation (EVS to use if "contact precautions") vs. our rigorous, microbiologically-based inclusion criteria (documented positive cultures). The clinical operations-approach was constructed to cast a "wide net" in order to capture the majority of patient who would meet study inclusion/exclusion criteria. The specific analyses to identify qualifying patients were not completed until the end of each arm. After comparing the populations captured by the clinical operations-approach and the study inclusion-approach, the following Venn diagram can be constructed:



As noted in Figure 1 of the manuscript, 10,616 patients were included in our ITT analyses in the UV and UV and bleach arms. Of these, 6,549 had a documented use of the UV device. Thus, the 4,067 additional patients represent patients who entered a microbiologically-proven "seed" room but in which use of the UV device was not documented. There are at least three explanations for why this scenario would occur. First, the results of the microbiological culture that led to the room qualifying as a seed room were not yet available at the time the patient was discharged from the room. Thus, the criteria for placing the patient on contact precautions (the trigger for the EVS team to use the study protocol) were not met, and the room was cleaned as any other room in the hospital. We suspect this scenario explains the majority of these patients. Second, the patient in the seed room was indeed on contact precautions, but the room was missed. As noted in Table 5 of the manuscript, ~11-12% of rooms were missed. Finally, it is conceivable that the UV device was used in these rooms but not documented. Regardless of which reason, the inclusion of these patients in our ITT analyses would have biased our results towards the null.

Of the 21,844 uses of the UV device, 15,295 uses occurred in rooms that ultimately did not meet inclusion criteria for our ITT analyses. That is, the study cleaning protocol was applied to a room that did not ultimately meet our criteria as a seed room. We believe there are at least five potential explanations for this scenario. First, as demonstrated in Figure 1 in the manuscript, over 5,000 patients admitted to seed rooms were excluded because they met one of our exclusion criteria. By study protocol, the UV device would have been used in these rooms despite that the fact that they were ultimately excluded from our analyses. Second, patients may have been placed in contact precautions for a remote (>12 month) history of infection/colonization with one of our target organisms. While our study criteria only considered results within the prior 12 months to be indicative of current colonization, all hospitals involved had policies in place whereby prior history with 3 of the target organisms (MRSA, VRE, MDR Acinetobacter) were placed on contact precautions, even if the history was more than 12 months prior to the index hospitalization. Third, the patient may have been on contact precautions for other clinically important organisms (e.g., norovirus, MDR Gram negative rods). Fourth, the patient may have been on contact precautions based on "syndromic surveillance." That is, patients with diarrhea may have been preemptively placed on contact precautions. If discharged prior to confirmation of the cause of diarrhea (or disproving *C. difficile*), these patients' rooms would have been cleaned according to our study protocols. Finally, we know from discussions with local EVS personnel that the UV devices were occasionally used "by request".

Hospital-level Variables and Adverse Events

Hospital-level variables and adverse events were measured at each study hospital. Local hospital personnel monitored hand hygiene compliance throughout the study. Hospitals were not instructed on specific methods for hand hygiene monitoring, but were asked to maintain the same approach throughout the study. EVS supervisors also objectively monitored room cleaning throughout the study. Hospitals were provided fluorescent markers and electronic handheld devices to enter data for room monitoring (DAZO and EnCompass System, Ecolab, St. Paul, Minnesota). EVS supervisors measured cleaning compliance by marking a minimum of five locations in seed rooms after discharge of the patient but prior to cleaning by the housekeeper. Monitoring was performed in a minimum of five seed rooms each week. Compliance was defined as the number of areas wiped by the housekeeper per number of locations marked by the supervisor per room. Supervisors were instructed to rotate the locations each week. Most hospitals used summary information available through the EnCompass portal for regular data review and presentation at administrative meetings. Colonization pressure was measured as the proportion of patients with a positive culture for one of the target organisms admitted to a study hospital per month.

Room turnover time was measured two ways: the time from the room being declared dirty to being declared clean and ready for the next patient (the "total turnover time") and the time from the initiation of room cleaning to the room being declared clean and ready for the next patient (the "cleaning time"). Patient wait time in the emergency room was measured as the amount of time between the ED physician's decision to admit the patient and departure from the ED. Several hospitals were not able to provide these data and instead provided the amount of time from arrival to the ED to departure from the ED for admitted patients. Finally, diversion was calculated as the number of hours the study hospital was on any form of diversion during each study arm. Two hospitals had policies whereby they were not allowed to go on diversion and were excluded from this analysis.

Microbiological Analysis

We performed a microbiological analysis of randomly selected seed rooms at two study hospitals to determine the total and average number of colony forming units (CFU) of the four target organisms that remained in the hospital room following terminal room disinfection (Web Extra Supplemental Materials). We evaluated 10 environmental locations (i.e., bathroom floor, bed rail, chair, overbed table, side counter, shower floor, sink, toilet, linen hamper lid, and medicine cart) in the rooms; each location was sampled repeatedly using 10 replicate organism detection and counting (RODAC) plates (5 aerobic and 5 anaerobic) to enhance microbiological yield and reduce sampling error. Five Rodac plates sample 125 cm^2. A total of 92 rooms were sampled, including 21 during the reference arm, 28 during the UV arm, 23 during the bleach arm, and 20 during the bleach and UV arm.

Supplement to the Results Section

Use of UV Devices

A UV device was used a total of 21,844 times at study hospitals. A vegetative cycle was used 16,313 (75%) times; a spore cycle was used 3,651 (17%) times. The type of cycle was not documented 1,880 (9%) times. Of 21,431 cycles with documented time, the cycle completed 21,189 times (97%; range per hospital 90·8% to 98·8%). The median cycle time was 33 minutes (IQR 25 to 46). The vegetative cycle took a median of 30 minutes (IQR 24 to 41), and the spore cycle took a median of 55 minutes (IQR 41 to 71).

Protocol Compliance and Hospital-level Variables

Infection prevention teams at each hospital led hand hygiene observations in study hospitals. A total of 283,777 hand hygiene observations were performed during the study (median observations per study hospital=19,001 [13,558-34,396]); HCP performed hand hygiene during 258,435 (91%) of the observations. The median hand hygiene compliance per hospital was 89·8% (IQR 83·3 to 94·1).

EVS supervisors objectively monitored cleaning compliance in 20,436 rooms during the study (median number of rooms monitored per study hospital=1,691, IQR [575 to 2,623]; 247,850 (92%) of 269,841 specific locations in the monitored rooms were cleaned. The median compliance per room was 93% (IQR 85 to 94·5). Cleaning compliance was highest during the reference period. Hospital-level for each hospital is provided in Supplemental Table 4.

Finally, colonization pressure was equivalent between the different study arms; the prevalence of patients admitted to study hospitals with a target organism was generally similar across study arms.

Time to Outcomes

A total of 390 (92%) outcomes were identified after the exposed patient was discharged from the seed room. The median time from discharge from the seed room to the outcome was 12 days for *C. difficile* (range 1 to 26), 28.5 days for VRE (range 1 to 89.6), and 37 days for MRSA (range 1 to 90).

Additional Details regarding Culture Data

The source of the cultures and the proportion of cultures representative of infection or colonization for each study period are provided in Supplemental Table 5.

Adverse Events

A total of 421,759 total room turnover times were analyzed during the study (median=44,309, IQR 33,143 to 66,708). The median total turnover time during the study was 85 minutes (IQR 62·6 to 151). The median total room turnover time was approximately 7 minutes higher when the UV device was employed (Table 4).

548,494 room cleaning times were analyzed during the study period (median number of documented room cleanings per hospital=44,587, IQR 37,250 to 87,187). The overall median room cleaning time during the study was 38 minutes (9 hospitals; IQR 28·1 to 89·4). The median room cleaning time was approximately 4 minutes higher when the UV device was employed in target rooms.

Seven hospitals provided data on the total amount of time 129,426 patients spent in the emergency department (ED) prior to transfer to a hospital room. The total wait time in the ED was essentially unchanged across cleaning arms (Table 4). Four hospitals provided data on the amount of time 87,766 patients spent in the ED after the decision to admit was made. Patients spent approximately 10-20 minutes longer in the ED after the decision to admit was made during the three intervention arms.

Study hospitals were on diversion a total of 202·3 days during the study. The median number of days on diversion per month for all hospitals was 0·28 (IQR 0 to 1·21). Overall, the median number of days on diversion per hospital during the intervention arms was similar to or lower than the time on diversion per hospital during the reference arm (Table 4).

One hospital reported a single UV exposure event during the course of the study. A charge nurse attempted to turn off the UV device while it was being used in a room. She could not find the remote control for the unit, so she entered the room to unplug the machine. She subsequently reported to occupational health with headaches and seeing “sun spots.” She was evaluated and given symptomatic therapy and had no permanent complaints. This event, however, led to the cessation of the use of the UV device in this hospital for approximately 6 weeks while safety concerns were evaluated and additional precautionary steps were developed and implemented.

Supplemental Table 1. Hospitals participating in the Benefits of Enhanced Terminal Room (BETR) Disinfection Study

Hospital	Location	Bed Size	Type
Alamance Regional Medical Center	Burlington, NC	218	Community
Chesapeake Regional Medical Center	Chesapeake, VA	310	Community
Duke Raleigh Hospital	Raleigh, NC	148	Community
Duke Regional Hospital	Durham, NC	202	Community
Duke University Hospital	Durham, NC	950	Tertiary
Durham Veterans Affairs Medical Center	Durham, NC	271	Veterans Affairs
High Point Regional Health System	High Point, NC	335	Community
Rex Hospital	Raleigh, NC	660	Community
University of North Carolina Hospitals	Chapel Hill, NC	853	Tertiary

Supplemental Table 2. Incidence of target organisms among eligible exposed patients at individual study hospitals following the use of four strategies for terminal room disinfection in 9 hospitals; Intention-to-treat analysis, rates per 10,000 exposure-days.

	Terminal Cleaning Strategy							
Hospital	**Quaternary ammonium except Hypochlorite for *C. difficile***		**Quaternary ammonium + UV device except Hypochlorite + UV device for *C. difficile***		**Hypochlorite**		**Hypochlorite + UV device**	
All target organisms	**n/exposure days**	**Rate**	**n/exposure days**	**Rate**	**n/exposure days**	**Rate**	**n/exposure days**	**Rate**
1	4/1732	23·1	13/2399	54·2	8/2544	31·4	17/3509	48·4
2	53/9758	54·3	24/7008	34·2	40/7329	54·6	64/11070	57·8
3	3/635	47·3	1/968	10·3	5/1195	41·9	2/1065	18·8
4	3/1168	25·7	2/932	21·5	3/1157	25·9	4/1478	27·1
5	1/574	17·5	0/669	0	2/654	30·6	2/593	33·7
6	10/1293	77·3	4/947	42·2	14/2114	66·2	8/1271	62·9
7	26/2559	102	16/2680	60·0	14/2258	62·0	19/2729	69·6
8	12/3903	30·7	15/5848	25·7	11/5996	18·3	14/6261	22·4
9	3/808	37·1	1/938	10·7	4/1014	39·4	1/781	12·8
***Clostridium difficile*[a]**								
1	0/557	0	2/609	32·8	0/866	0	1/523	19·1
2	6/1939	30·9	5/1538	32·5	6/1545	38·8	5/2111	23·7
3	1/302	33·1	0/427	0	2/382	52·3	2/479	41·8
4	2/463	43·2	2/420	47·7	0/269	0	1/431	23·2
5	0/184	0	0/196	0	0/181	0	1/164	61·1
6	0/290	0	0/187	0	6/325	185	0/285	0
7	5/476	105	2/442	45·2	0/253	0	1/391	25·6
8	2/1345	14·9	8/1999	40·0	4/1431	28·0	7/1842	38·0
9	0/262	0	0/255	0	2/314	63·7	1/210	47·6
Methicillin-resistant *Staphylococcus aureus* (MRSA)								
1	3/1136	26·4	11/1809	60·8	9/1781	50·5	17/3023	56·2
2	21/5815	36·1	12/4380	27·4	19/4351	43·7	32/6896	46·4
3	3/358	83·8	1/491	20·4	3/725	41·4	0/553	0
4	1/665	15·0	0/555	0	2/867	23·1	4/1008	39·7
5	1/358	27·9	1/431	23·2	2/467	42·8	1/445	22·5

6	9/1263	71·3	6/844	71·1	12/1982	60·5	8/1190	67·2
7	24/2149	112	14/2244	62·4	18/1893	95·1	21/2076	101
8	8/2260	35·4	8/3416	23·4	6/2578	23·3	6/3254	18·4
9	3/523	57·3	1/610	16·4	3/699	42·9	0/516	0
Vancomycin-resistant enterococci (VRE)								
1	1/205	48·8	2/402	49·8	0/395	0	1/805	12·4
2	33/4016	82·2	15/2826	53·1	21/3015	69·7	33/4345	76·0
3	0/48	0	0/92	0	0/133	0	0/83	0
4	0/180	0	0/37	0	1/129	77·8	0/205	0
5	0/46	0	0/114	0	0/52	0	0/42	0
6	1/199	50·3	0/139	0	0/104	0	0/210	0
7	0/302	0	0/751	0	0/633	0	0/1009	0
8	2/784	25·5	0/1287	0	2/2954	6·77	3/2706	11·1
9	0/58	0	0/134	0	0/107	0	0/84	0
MDR *Acinetobacter*								
1	0/0	0	0/60	0	0/14	0	0/65	0
2	0/77	0	0/56	0	0/11	0	0/75	0
3	0/0	0	0/0	0	0/10	0	0/2	0
4	0/54	0	0/31	0	0/7	0	0/31	0
5	0/9	0	0/0	0	0/9	0	0/8	0
6	0/0	0	0/0	0	0/0	0	0/0	0
7	0/2	0	0/20	0	0/4	0	0/5	0
8	0/14	0	0/30	0	1/32	30·8	0/37	0
9	0/0	0	0/2	0	0/10	0	0/23	0

a – Rooms with patients known or suspected of having *C. difficile* infection were terminally cleaned with bleach-containing solutions

Supplemental Table 3. Post-hoc analyses of incidence of target organisms among eligible exposed patients following the use of four strategies for terminal room disinfection in 9 hospitals; Intention-to-treat analysis, rates per 10,000 exposure-days.

	Terminal Cleaning Strategy			
	Quaternary ammonium except Hypochlorite for *C. difficile*[a]	**Quaternary ammonium + UV device except Hypochlorite + UV device for *C. difficile*[a]**	**Hypochlorite**	**Hypochlorite + UV device**
Analysis 1 (remove 24 hour requirement)[b]	**N=6,281**	**N=6,714**	**N=6,998**	**N=7,507**
Patient outcomes (%)	131 (2·1)	94 (1·4)	122 (1·7)	149 (2·0)
Exposure days	23,312	23,339	25,260	29,419
Rate	56·2	40·3	48·3	50·6
Risk reduction (95% CI)	*ref*	15·9 (4·9 to 26·9)	7·9 (-4·9 to 20·7)	5·6 (-6·9 to 18·0)
RR (95% CI); p-value	*ref*	0·70 (0·49 to 0·99); 0·046	0·88 (0·67 to 1·16); 0·36	0·93 (0·79 to 1·08); 0·34
Analysis 2 (remove *C. difficile*)[c]	**N=3,740**	**N=3,920**	**N=4,334**	**N=4,663**
Patient outcomes (%)	97 (2·6)	56 (1·4)	83 (1·9)	105 (2·3)
Exposure days	17,195	16,915	19,211	22,982
Rate	56·4	33·1	43·2	45·7
Risk reduction (95% CI)	*ref*	23·3 (9·9 to 36·7)	13·2 (-0·3 to 26·8)	10·7 (-0·9 to 22·4)
RR (95% CI); p-value	*ref*	0·63 (0·47 to 0·84); 0·002	0·83 (0·64 to 1·06); 0·14	0·82 (0·67 to 0·998); 0·048

a – Rooms with patients known or suspected of having *C. difficile* infection were terminally cleaned with hypochlorite-containing solutions

b – Patients were included in this analysis if they spent any amount of time in a seed room

c – All patients admitted to *C. difficile* seed rooms were excluded from this analysis

Supplemental Table 4. Monthly estimates of hospital-level variables per study arm for 9 study hospitals participating in the Benefits of Enhanced Terminal Room (BETR) Disinfection study.

	Terminal Cleaning Strategy			
	Quaternary ammonium except Hypochlorite for *C. difficile*	**Quaternary ammonium + UV device except Hypochlorite + UV device for *C. difficile***	**Hypochlorite**	**Hypochlorite + UV device**
Hospital				
Median (range) of monthly hand hygiene compliance percentage				
1	88 (84 to 93)	89 (75 to 96)	59 (48 to 70)	93 (87 to 95)
2	85 (83 to 88)	89 (87 to 91)	91 (90 to 93)	94 (92 to 96)
3	86 (84 to 90)	84 (80 to 87)	89 (85 to 91)	81 (63 to 86)
4	90 (84 to 93)	88 (87 to 91)	94 (89 to 95)	90 (88 to 94)
5	95 (90 to 98)	96 (95 to 96)	96 (95 to 96)	91 (94 to 98)
6	73 (71 to 77)	82 (74 to 87)	86 (67 to 89)	83 (73 to 86)
7	99 (97 to 100)	99 (99 to 100)	99 (97 to 99)	99 (97 to 100)
8	92 (88 to 97)	85 (82 to 89)	83 (80 to 84)	82 (81 to 90)
9	97 (97 to 98)	98 (96 to 99)	97 (96 to 98)	97 (96 to 98)
Median (range) of monthly room cleaning compliance percentage				
1	93 (73 to 99)	81 (71 to 88)	91 (82 to 95)	91 (88 to 94)
2	82 (66 to 88)	84 (79 to 88)	92 (84 to 95)	84 (78 to 90)
3	97 (93 to 98)	91 (75 to 95)	93 (93 to 94)	94 (90 to 100)
4	95 (90 to 97)	99 (99 to 99)	85 (70 to 92)	86 (81 to 94)
5	95 (90 to 98)	94 (90 to 98)	93 (88 to 94)	91 (88 to 98)
6	100 (97 to 100)	100 (98 to 100)	97 (80 to 99)	90 (82 to 98)
7	87 (80 to 89)	90 (80 to 92)	92 (91 to 98)	91 (89 to 96)
8	94 (92 to 95)	91 (89 to 95)	90 (86 to 91)	87 (79 to 90)
9	99 (98 to 100)	100 (99 to 100)	99 (97 to 100)	100 (100 to 100)
Median (range) of monthly estimate for colonization pressure/100 admissions				
1	4·5 (3·9 to 4·9)	4·6 (4·1 to 5·3)	4·9 (3·7 to 5·1)	5·2 (4·0 to 6·8)
2	10·5 (9·6 to 12·7)	4·2 (3·5 to 4·5)	4·5 (4·4 to 5·1)	9·9 (9·6 to 11·1)
3	1·6 (1·3 to 2·7)	2·2 (1·5 to 2·3)	2·3 (2·1 to 3·1)	1·9 (0·7 to 2·5)
4	2·1 (1·5 to 2·5)	4·2 (3·2 to 5·6)	3·9 (3·2 to 5·4)	2·6 (1·8 to 3·7)
5	4·1 (2·9 to 5·4)	5·7 (2·9 to 7·8)	4·1 (2·9 to 5·1)	4·4 (3·2 to 5·9)

6	33·7 (28·5 to 37·2)	29·2 (25·4 to 33·5)	28·7 (23·4 to 31·1)	27·3 (24·8 to 32·7)
7	5·4 (4·5 to 6·2)	7·5 (6·9 to 9·0)	7·2 (5·7 to 8·8)	6·3 (6·0 to 8·3)
8	9·2 (6·2 to 10·1)	3·7 (2·7 to 4·2)	3·8 (3·2 to 4·0)	4·0 (3·6 to 5·4)
9	3·5 (3·0 to 4·9)	3·5 (2·9 to 5·2)	5·7 (3·4 to 6·3)	3·7 (3·1 to 4·9)

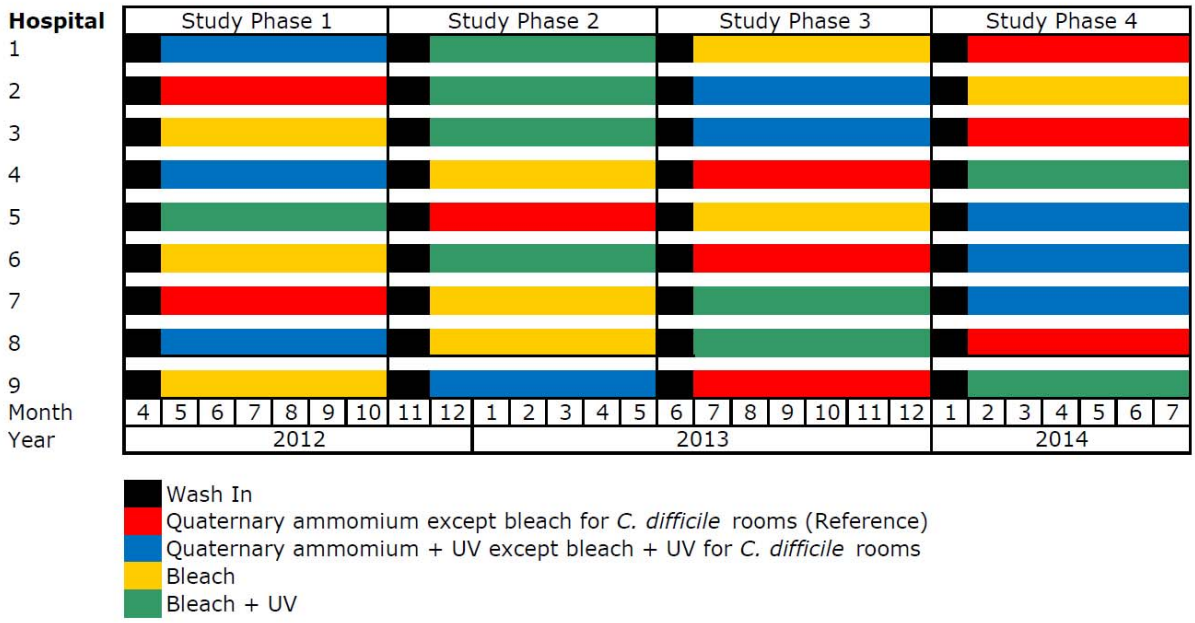
Supplemental Table 5. Culture Source of 228 Infections Observed during the BETR Disinfection Study

Culture source	**N=154 n (%)**
Blood	22 (9·6)
Bone/Joint/Synovial Fluid	6 (2·6)
Sputum	43 (18·9)
Stool[a]	74 (32·5)
Urine	22 (9·6)
Wound	57 (25·0)
Other[b]	4 (1·8)

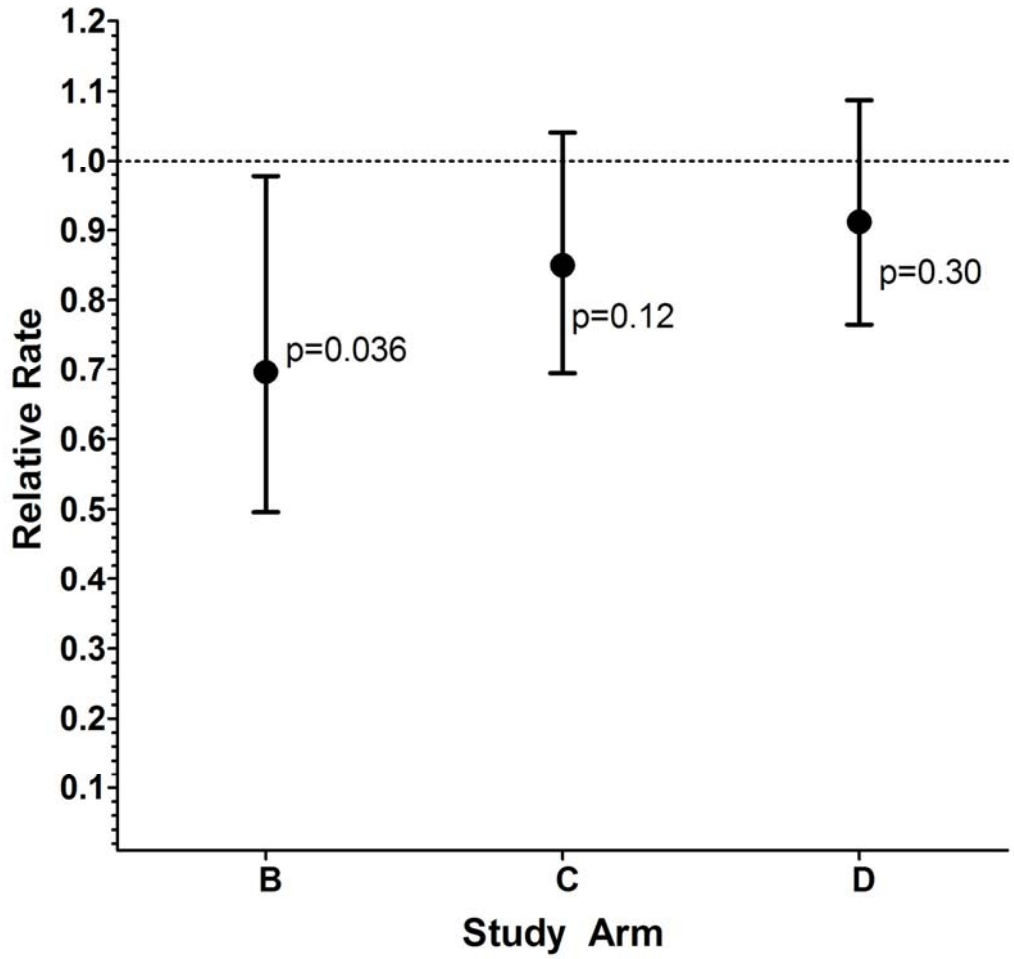
a – All *C. difficile* infections

b - Includes sinus culture (n=1), pleural culture (n=1) and cultures labeled as “fluid” or “tissue” but no other descriptors (n=2).

Supplemental Figure 1. Four Strategies for Terminal Room Disinfection in the Benefits of Enhanced Terminal Room (BETR) Disinfection Study - Randomization scheme for 9 study hospitals

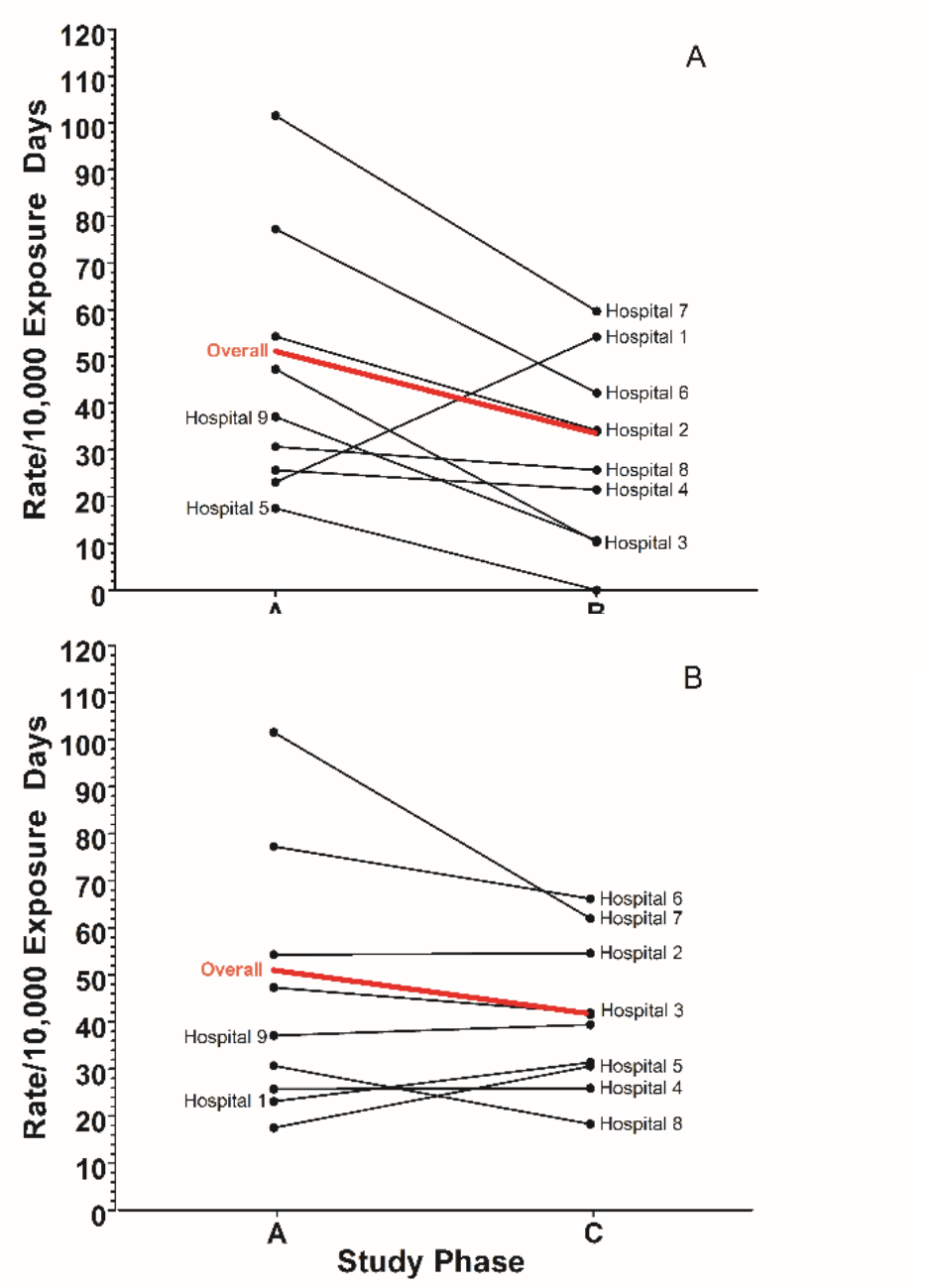


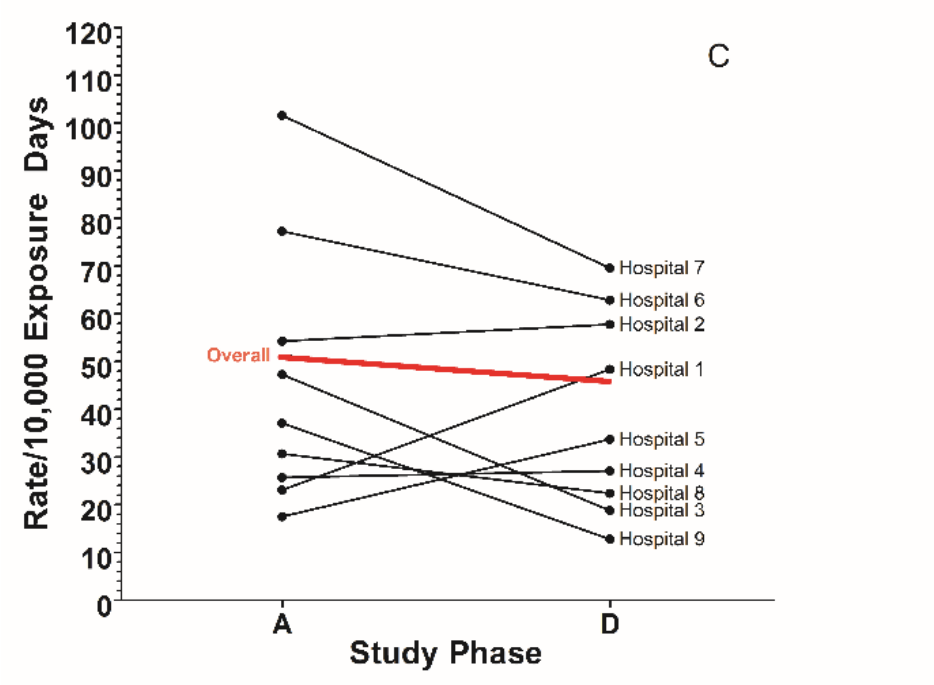
Supplemental Figure 2. Relative risks of incidence of target organisms among exposed patients following the use of three strategies for enhanced terminal room disinfection compared to standard cleaning.



Strategies included: B - Quaternary ammonium-containing solution + UV device except bleach-containing solution + UV device for *C. difficile; C* – Bleach-containing solution; D – Bleach-containing solution + UV device. Each compared against standard terminal room disinfection strategy - Quaternary ammonium-containing solution except bleach-containing solution for *C. difficile*

Supplemental Figure 3. Changes in hospital rates for each enhanced terminal room disinfection strategy compared to standard disinfection.





3A – compare study phase B (UV arm) to study phase A (reference arm)

3B – compare study phase C (bleach arm) to study phase A (reference arm)

3C – compare study phase D (bleach and UV arm) to study phase A (reference arm)

Strategies included: B - Quaternary ammonium-containing solution + UV device except bleach-containing solution + UV device for *C. difficile; C* – Bleach-containing solution; D – Bleach-containing solution + UV device. Each compared against standard terminal room disinfection strategy - Quaternary ammonium-containing solution except bleach-containing solution for *C. difficile*